

Artificial Societies

"Chaos Revisited" Plancton Art Studio



Realized in 1999, this image was selected for the *Art Gallery at Siggraph 1999 Los Angeles* (mentioned as a highlight of that event), reported on the front cover of the *Art Catalogue*, and utilized for a three year "travelling show" in several exhibitions across The United States.



The Fractures

In 1994, after some tentative tries with cellulose and Indian ink, I tried to reproduce ink fractures on the computer. A lucky conceptual mistake happened: instead of a mechanic model I made use of an *animistic* model. Inside it, the fractures moved autonomously, according to a genetic code of numeric parameters. Living patterns of filaments were generated by this experiment: natural, human and artificial shapes, ancestral dreams. The *vital quality* of the image came from the dynamic of the whole population of fractures-filaments. Immediately I looked for the keyword *artificial societies* on the web in order to discover some artists working on these architectures. The research failed but in the next tentative work on *artificial life* I found the site of SantaFé Institute and the other site of the a-life world.

In the subsequent years, following and experimenting with the researches of the *alife* environments, I met other artists seduced by life concepts, self-organization and artificial societies. These artists, coming from different experiences, are now recognizing themselves and meeting, sharing an expressive research not yet well defined. This research tries to explore the creative capacities of the complexity and the relation between real and virtual worlds. The collection of the short articles herewith enclosed is not a complete overview of this trend. The purpose is to refer to a moment of *germination* of the discussion which took place during a workshop on *Alife and Art* organized by Christa Sommerer inside ALIFE VII, the biennial international conference on Artificial Life (Portland, August 2000).

Pattern of Convergence

The recent trends in information and communication technologies reveal an impressive convergence among artificial intelligence, virtual reality and artificial life. More and more projects involving environments where real people can interact with artificial entities are changing the concept of *virtual reality* in a *virtual world*. The efforts regarding the development of *autonomous agents* in a *virtual environment* raise basic questions related to the current definition of such terms as *plife*, intelligence, and evolution. This convergence is stimulating new architectures and producing paradigm shifts. The *man-machine interface* is shifting into *hybrid ecosystems* of real and artificial beings. The environment is no longer a *static virtual set*, but rather a *dynamic environment*, co-evolving under the action of the living agents. Interaction and dynamics in such worlds cannot be based on a list of action-reaction correspondences, but should be based on an open evolution, where genetics and self-organization allow the survival of the overall system.

An impressive amount of progress has been made in the field of the autonomous behavior of digital and physical entities (robots). The historical dream of Von Neuman of self-reproducing machines seems today more at hand: new advances showed simulated machines able to develop an increase in complexity at each self-reproduction stage. The self-reproducing machines, the self-learning toy-robots, the current experimentation on robots developing a communication language, put new steps on the possibility that artificial beings could develop a sort of *primitive culture*. An interesting dimension has been shown by the use of the evolution of *artificial societies* in order to simulate economic trends or develop the control strategy for complex industrial processes.

(continued on page 6)

Forums

YLEM Autumn Events

YLEM's 20th Anniversary Arts Festival, September 2001

"The Impact of YLEM: Twenty years of Art, Science and Technology"
SomArts Gallery, 934 Brannan St., San Francisco, CA 94103. Works
by 80 innovative Ylem artists that span two decades, and two instal-
lations built especially for the exhibit. September 4 through 22, 2001,
Opening Party on Thursday, September 6, 5:30-7:30
CyberArts X Party, Sept 15, \$25 donation, benefit YLEM

Other 20th Anniversary Events:

CyberArts X Conference, Exploratorium Sept.15-16, 8-Midnight. Info
and tickets:

<www.cyberarts.org>

Also celebrates the tenth anniversary of first CyberArts Conference
produced by Robert Gelman in L.A. Artists, developers and futurists
discuss next developments in online avatars, graphics and animation,
social computing, future themeparks, VR, psychoacoustics. They as-
sess the future, rethinking the social impact of digital media, and pre-
sent extreme visions of art, intelligence, and AI.

YLEM'S ONE HUNDRETH FORUM!

YLEM Forum: Creme de la Creme!
Wednesday, September 19, 7:30 PM
McBean Theater

The Exploratorium

Author Dr. Leonard Shlain and composer/dancer Sylvia Pengilly, plus works
by Larry Cuba, Peter King and Lucia Grossberger Morales and 1989 video
about Ylem.

In the Planning Stages.

November Forum, Nov. 14th, 7:30 pm SOMARTS Gallery, 934 Brannan, San
Francisco

(Note change of location)

"Worshipping Science in the Temple of Art" by Larry Ackerman, John Scarpa,
Will Cloughley and Dale McDonald in conjunction with their exhibit at the
gallery. Info on exhibit at: www.SaintRubidium.com

<<http://www.SaintRubidium.com>>

Check www.ylem.org for updates.



PICO_SCAN: Using Body Data to Create Artificial Life Forms

Laurent Mignonneau and Christa Sommerer

Artificial Life as a field of research attempts to synthesize life in silico by using computers to create virtual life. By definition life and artificial life should display the following characteristics: self-organization, metabolism, self-reproduction, and adaptive evolution. Until now, most Artificial Life inspired artworks have created artificial characters or creatures that display some kind of behavior but do not really feature all of the above characteristics. The modeling of artificial evolution is a major challenge in Artificial Life research as well as for Artificial Life artworks. In the past we have developed several interactive computer art systems that use artificial life principles in combination with user-machine interaction. [1]* The underlying aim of these systems is to study the application of Artificial Life principles to the creation of self-sustaining and evolving interactive artworks. The interaction of the audience with

these works has a significant impact on the evolution of the works; by linking the interaction parameters of the users' interactions to the evolutionary software structure of the system, we aim to create artworks that can interpret and visualize the users' interaction with these works and furthermore enable adaptive evolution within the works. To capture the users various interaction parameters and to link them to the evolutionary image processes of the works we often produce custom designed interfaces. These have so far included living plants [2], a drawing input device [3], light [4], a gesture recognition system [5] and a text input device [6]. While we have used one specific detection interface for each of these systems, we recently designed a new system called PICO_SCAN, that aims to capture various body data of the user and link them to the creation and metabolism of artificial life creatures.

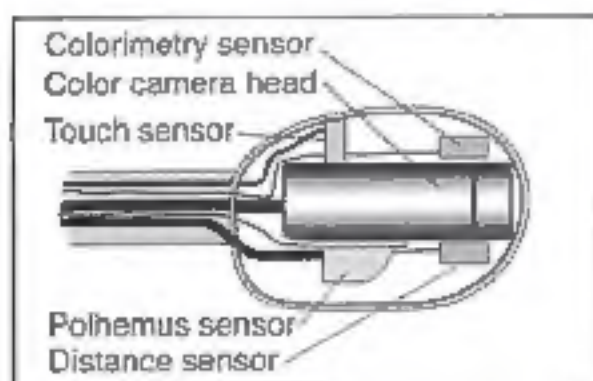


Figure 1: The PICO_SCANNER

PICO_SCAN System

The PICO_SCAN System consists of:

- a PICO_SCANNER interface device
- a 42 inch plasma video screen
- a video key mixer that can mix video and CG images.

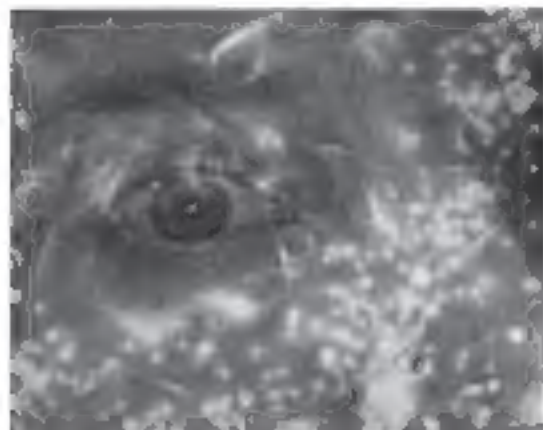
PICO_SCAN is designed to be very easy in its use: as the user scans along her own body she generates various input data that are specific to her own body. The collected data information is then used by the system to generate artificial life creatures that can feed on these data. Ultimately the aim is to create an artificial life environment where the creation, metabolism and evolution of these creatures is linked to the users individual interaction parameters. The PICO_SCANNER interface device consists of various sensors combined into one unit. These sensors are - 1 lipsick color video camera, 1 colorimetry sensor, 1 touch sensor, 1 3-D position sensor (Polhemus) and 1 distance sensor.

Figure 1 shows the PICO_SCANNER, which measures about 10 cm in length. When the user picks up the device and scans along her body she generates input data such as distance values, 3 D position values, color and colorimetry values as well as a video image. All data are voltage values that can be converted into digital values to be used for further calculations by the host computer.

* bracketed numbers are referenced at the end of articles where present.

In the case of PICO_SCANNER we use the digitally converted voltage values for the creation of artificial life creatures.

A specifically designed video mixer allows us to key between the video image captured by the lip-stick camera and the computer generated (CG) artificial life creatures. When the users holds the PICO_SCANNER at a distance of around 40 cm to her body, the device only captures the users video image. But when moving closer, the device generates images of artificial life creatures that are gradually mixed into the video image. This is done step-less through our in-house video mixer. The 3-D position sensor (Polhemus) and the distance sensor provide the necessary position data for calculating the distances between the users body and the PICO_SCANNER.



Creating Artificial Life Through Interaction

While most artificial life simulations are closed systems [7, 8, 9, 10] we aim to link the real world data of the users' interactions to the virtual world data of the artificial life creatures. To do so we use the color, colorimetry, distance, 3-D position and touch values captured by the PICO_SCANNER. In contrast to our previous systems where the creation process of creatures was directly mapped to the interface input data [11, 12], we start this time with a "soup" of random creatures. When not interacted with these virtual creatures exist but do not move or metabolize, they are inert and merely exist in the memory space of the host computer. Their condition could be compared to "hibernation." When the user picks up the PICO_SCANNER these creatures start to wake up and move. While scanning along her body different body data as well as a video images are being generated that influence the behaviour of the artificial crea-

Metabolism, Reproduction and Evolution

In the stage of "hibernation" a creature does not move or metabolize. As soon as activated it will start to move and consume energy. A creature's behaviour is basically dependent on two parameters: 1.) its Energy Level (E) and 2.) its Speed (S) or ability to move. While the Speed Value (S) of a creature is decided by its body shape and influences its ability to move, the Energy Level (E) is a value that constantly changes as the creatures moves in its environment: it decreases by increased body movement. The following table shows the correlation between Speed and Energy.

S = Speed, E = Energy

S ➤ depends on creatures body shape
decides how fast the creature can move
E ➤ 1 at birth

S of movement reduces **E**
...if $E < 1$ ➤ creature becomes hungry
...if $E > 1$ ➤ creature can mate

Each movement a creature performs costs energy. When the energy level reaches a certain threshold the creature becomes hungry and needs to eat. Food is provided by the user in form of food particles that can be released when pressing the touch button on the PICO_SCANNER. Small white food particles will appear that contain energy for the creatures. When a creature has moved and its energy level has dropped below the threshold of $E < 1$, it becomes hungry: to reach its target the creature will move towards the food particles and tries to metabolize its energy. Since each creature within the initial "soup" of creatures has a different Speed (S) value, creatures will have different capabilities to reach the food particles. Given that a creature succeeded to increase its internal energy level to $E > 1$, it will be ready to mate. The following table shows this correlation between Energy Level, Feeding and Mating Behaviour.

Feeding:

...if $E < 1$ ➤ creature wants to eat food particles it reaches the food according to its Speed Value

Mating:

...if $E > 1$ ➤ creature wants to mate, if successful, parents will exchange their genetic code ➤ a child creature can be born

When two creatures have accumulated enough energy they can start to mate with each other and create an offspring creature. In this case, the offspring inherits the genetic code of the parent creatures; this is done through cross-over of the parents' codes and application of minimal mutation. Cross-over can take place at any part of the genetic string and the location and length of the cross-over is decided at random, however it is adapted to the length of the genetic string.

The constant movement, feeding, mating and reproduction activities of the creatures result in a complex system of interactions with a selection for faster creatures. The user and her interaction decisions however will ultimately influence the crea-

tures' behaviour and their possible evolution. By feeding and reproducing certain types of creatures it is anticipated that the users interaction and the internal behaviour parameters of the creatures themselves can create a complex system that might display adaptive evolution with interactions between creatures and creatures as well as between users and creatures.

In our aim to create artworks that can be compared to living systems [13] PICO_SCAN represents a further attempt in the design of interaction that can link real life data with artificial life data through human-machine interaction. ■ ■



Figure 2: PICO_SCAN at the Martin Gropius Bau in Berlin April 2000.

Acknowledgement

The final exhibition of PICO_SCAN was shown at the exhibition "Images and Signs of the 21st Century" [14] at the Martin Gropius Bau in Berlin in April 2000. Figure 2 shows the final system set-up. The system was supported by the Berliner Festspiele GmbH and ATR MIC Labs Kyoto. We would like to especially thank Mr. Stephen Jones for his support on the hardware design.

References

- [1] Sommerer C, Mignonneau L (1998) The application of artificial life to interactive computer installations. *Artificial Life and Robotics Journal*, Tokyo: Springer Verlag, Vol 2, No.4, pp. 151-156.
- [2] Sommerer C, Mignonneau L (1993) Interactive Plant Growing. *Ars Electronica 93 - Genetic Art Artificial Life*. Vienna: PVS Verlag, pp. 408-414.
- [3] Sommerer C, Mignonneau L (1997) Interacting with Artificial Life: A-Value. *Complexity Journal*, Vol 2, No. 6, pp 13-21.
- [4] Sommerer C, Mignonneau L (1995) *Phototropy Oltre il villaggio globale - Beyond the Global Village*. Milan: Electra Edition, p 134.
- [5] Sommerer C, Mignonneau L (1996) MIC Exploration Space. *Siggraph'96 Visual Proceedings*, New York: ACM Siggraph, p. 17.
- [6] Sommerer C, Mignonneau L (1999), Life Species: a genetic text-to-form editor on the Internet. *Proceedings AROB 4th'99*, Beppu, Oita, pp. 73-77.
- [7] Sims K (1994) *Evolving 3D Morphology and Behavior by Competition*. Artificial Life IV. Boston: MIT Press, pp. 29-39.
- [8] Holland J H (1994) *Echoing emergence: Objectives, rough definitions, and speculations for Eco—class models. Complexity: Metaphors, Models and Reality*. Reading, MA: Addison-Wesley.
- [9] Ray T (1991) *An Approach to the Synthesis of Life*. Artificial Life II. Redwood City, Calif.: Addison-Wesley, pp. 371-408.
- [10] Jones S (2000) Sensing, Communication and Intentionality in Artificial Life. *Proceedings AROB 5th'00*, Oita.
- [11] Sommerer C, Mignonneau L (1999), Life Species II: from text to form on the Internet using language as genetic code. *ICAT'99 9th International Conference on Artificial Reality and Tele-Existence Conference Proceedings*, Virtual Reality Society, Tokyo, pp. 215-220.
- [12] Casti J (1999) The Art of Language. *Complexity Journal*, Vol.5, No.1, pp. 12-15.
- [13] Sommerer C, Mignonneau L (1998), *Art as a Living System*. Art @ Science. Springer Verlag, Vienna New York, pp 148-161.
- [14] Sommerer C, Mignonneau L (2000), PICO_SCAN - interactive computer installation. *7 Hills: Images and Signs of the 21st Century*. Henschel Verlag & Berliner Festspiele, Berlin, pp. 52-53.

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(continued from page 1)

Is It Life?

The basic questions raised by all these stimuli and advances are answered today, in the world of artificial life thinkers, in two ways: the *weak alifers* (all is just a simulation of life) and the *hard alifers* (it is possible create realizations of a new and real life form). A support for these interpretations comes from the concept of autopoiesis of Maturana and Varela as a network of production processes where the function of each component is to participate to the production of other components on the network. In *alife*-based systems, often it is really difficult to assess this property, and most of the time the concept of *evolvability* is used as a qualitative measure of a sort of *potential of life*. The intelligence of living beings is considered the result of collective accumulation of positive genetic and behavioral mutations and self-organization strategies, developed during a long evolution time. This concept, enunciated by J. Monod, can be the basis for an evolving artificial society. With a single computer we can realize good *alife* simulations, but the boundary of this world is really too narrow to achieve a high degree of *evolvability*.

The Art of Emergence

Several years ago, some artists started exploring the potential of artificial life concepts in artistic fields. The development of new languages and tools is transferring the visions of those artists into tangible objects. They followed many directions to express the richness of the idea of *evolution*: a progressive increase of aesthetics, the development of intelligence or emotionality, the emergence of complexity. In most of the cases, the suggestion is focussed on the evolution of one or a few individuals.

The starting point of the experiences collected in this issue corresponds to the shift from the dimension of the single towards the group. The idea is that the qualities (aesthetics, intelligence, behavior, interaction) of these *entities* emerge not as a property of a single one, but as a collective property of an interacting-evolving group. This difference is fundamental and it distinguishes the artworks deriving from this approach for their *social dimension*. In these experiences the artwork is a generative context of shapes and reactions that appear as *emergent qualities* during the evolution process (It could be referred to as *art of emergence*). The creative process is a dynamic and dialectical interference between the artist and the artwork in order to drive, improve, select or simply open the final result. The interaction with the people or with the web community can open the evolution through a creative contamination between humans and artificial

The translation of these experiences on a network of computers can raise the possibility of development of an autonomous digital life. Some experiences in this sense are reference points (the project Tierra of Tom Ray, the intelligent avatars; see the experiences of the Biota group, www.biota.org). The provocative thesis we propose to discuss (or simply imagine), is that we are at the birth of the first world-wide artificial society. We have to wait several decades to achieve enough computational power, enough network space, enough degree of evolvability, but presently we are founding the bases of a new life dimension. In the Monod anticipation, the steps in the evolution are connected with the availability of new lands, new technology, new environmental conditions like the moving of life from sea to earth or the emergence of the language as base for cultural development. In this sense we identify the computers and the internet network both as new technology and new land available for a further step in evolution.

individuals: it can translate the artist-artwork-observers system in a co-evolution process of a *hybrid imaginary ecosystem* able to generate metaphors for the mind, for the real society and for the dynamics of communication.

Artificial Societies: Why?

I would like to conclude this introduction with a question. What will be the future relationships between humans and artificial societies? Will they be really world-wide, autonomous, useful, dangerous, or will they be a cultural or aesthetic exploration? In one question: exploring artificial societies, *why do it?* I think there isn't a single answer to this question, but each one of us has one. Personally, I see the artificial beings as a reflex-extension of the human beings in the digital domain. Exploring this dimension is still a sort of exploration of our nature in different dimensions we have to prepare to create. But this is only one of the thousand possible answers.

Autopoiesis

Kenneth Rinaldo

Autopoiesis is an artificial life robotic series commissioned by the Kiasma Museum in Helsinki, Finland. It consists of fifteen musical and robotic sculptures that interact with the public and modify their behaviors based on the both the presence of the participants in the exhibition and the communication between each separate sculpture. Autopoiesis is "self making", a characteristic of all living systems. This characteristic of living systems was defined and refined by Francisco Varela and Humberto Maturana. The structures themselves are constructed of cabernet sauvignon grapevines pulled into compression with steel wires. The joints are a custom molded urethane plastic, which is all, tied together using cyanoacrylate and baking soda. The grapevines were selected to create an approachable natural sculpture that exists in the human biological realm.

This series of robotic sculptures talk with each other through a hardwired network and audible telephone tones, which are a musical language for the group. Autopoiesis breaks out of standard inter-

faces (mouse) and playback methodologies (CRT) and presents an interactive environment, which is immersive, detailed and able to evolve in real time by utilizing feedback and interaction from audience/participant members. The interactivity engages the viewer/participant who in turn affects the system's evolution and emergence. This creates a system evolution as well as an overall group sculptural aesthetic.

Autopoiesis utilizes a number of unique approaches to create this complex and evolving environment. It uses smart sensor organization that senses the presence of the viewer/participant and allows the robotic sculpture to respond intelligently. I have used smart sensor organization in past papers to describe the process of organizing the sensors in such a way that they can be minimized in number while maximizing the abilities of the software to cope with the data. This idea was also explored at the Fourth Neuromorphic Engineering workshop at the Telluride Summer Research Center where participants noted that just a few sensors can be used to create complex interaction if the sensors are properly organized. For example, at the top of each sculptural element (or arm) four passive infrared sensors face North, South, East and west. When two sensors are triggered, the program knows that someone is located in, for instance, the Southeast corner and this is the direction the sculpture moves to. Four sensors allow eight quadrants of sensing. These passive infrared sensors tell each arm to move in the direction of the viewer, while the active infrared sensor located at the tip stops the arm as it arrives within inches of the viewer. This allows the sculpture to display both attraction and repulsion behaviors.

Furthermore, in Autopoiesis the robotic sensors compare their sensor data through a central-state controller, so the viewer is able to walk through the sculptural installation and have the arms interact both individually and as a group.

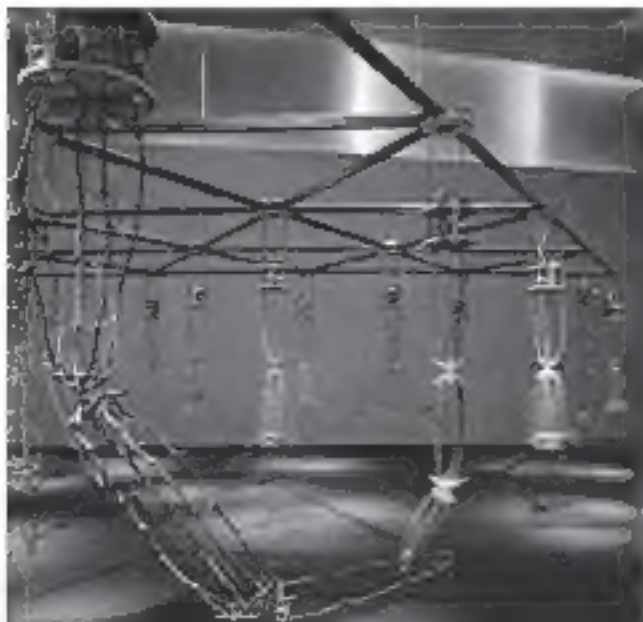


Figure 1: Autopoiesis at the Kiasma Museum of Contemporary Art, Helsinki

Because each arm has its own on-board custom built RISC PIC computer control, the overall speed of reaction is rapid and therefore, life-like. Local control always supercedes group control when a local sensor is aware of a human nearby. The software programmed in c and the hardware are structured with the subsumption architecture defined by Rodney Brooks in which the intelligence of the system is distributed to the farthest reaches of the system. For example each infrared sensor both active and passive are in essence minicomputers that provide only the data necessary to the local computer on each arm and to the global computer that connects all the arms. Each arms local computer handles only local interaction and the speed of the RISC controllers is rapid and over designed to allow individual arms to show accuracy and delicacy of approach and avoidance when encountering the viewer/participant.

At the tip of two of the arms, lipstick cameras project what they see onto the walls of the space. This gives the viewer/participant a sense of being observed by this artificial life robotic sculpture.

The sculptures communicate using bit strings as they exchange this data serially via a 485 network, which interconnects all the sculptures to a central state TERN control board. Each sculpture also

generates bit strings of information which are funneled into the central state controller and the number of participants in the exhibition gives this controller "a feel" for the global environment. If the global controller gets many sensor hits then the group behavior is less vigorous and more tentative, while if the global controller gets fewer hits over time, then the arms' behaviors become more vigorous and large-group behaviors are expressed. An internal numerical randomizer keeps the behaviors evolving and changing over time in response to these factors. These randomizers effect overall sculptural form and the evolution of the sound environment as well. Some of the behaviors you will notice in the video are "follow the leader" where one arm is passing a "mimic me" message to the next arm etc. Or flocking behavior where they are all moving simultaneously, or flock out from the center where the arm in the center sends a message for the other arms to follow.

The telephone tones are a musical language that allows individual robotic sculptures to communicate and give the viewer a sense of the emotional state of the sculptural elements as they interact. Higher and more rapid tones are associated with

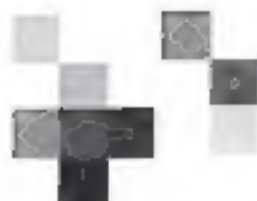
fear and the lower, more deliberate tonal sequences with relaxation and play. Other tones give the impression of the sculptures whistling to themselves. The telephone tones are a consistent language of intercommunication and manifest a sense of overall robotic group consciousness, where what is said by one effects what is said by others.

Autopolesis continually evolves its own behaviors in response to the unique environment and viewer/participant inputs. This group consciousness of sculptural robots manifests a cybernetic ballet of experience, with the computer/machine and viewer/participant involved in a grand dance of one sensing and responding to the other.

Special Thanks to: Amy Youngs, Dan Shellenberger, Jesse Hemminger, Jenny Macy, Chris Goss, John Morrow, The Department of Art, and The Kiasma Museum of Contemporary Art for their assistance and financial support in realizing this project.



Figure 2: Autopolesis with video projection of one of the arms cameras.



Emerging Relationships

Mauro Annunziato, Piero Pierucci

The experience of Planckon Art Studio with the creation of artificial societies started with an experiment exposed the first time in '94 (The Nagual Experiment, Viterbo, Italy, ONOFF Gallery) and published for the first time in '98 [1,2]. This experiment consisted in producing black-white images with autonomously growing filaments in an artificial life environment; the result was impressive for the possibility of showing social dynamics like the development of cultural biodiversity, pioneering, unconscious cooperation, and development of social class stratification. Furthermore, the images showed an incredible emulation of natural shapes. From this experiment we understood that these kinds of environments contain a massive potential for expression of social/communication dynamics.

Emergence

Relazioni Emergenti (Emergent Relationships) is an interactive installation shown the first time in '99 at Opera Totale (Venice, IT) and in 2000 at Imagina (Monaco, France) and Siggraph (New Orleans, CA). The installation is based on a life environment of artificial individuals endowed with their own autonomy and character. They can interact, reproduce, and evolve through the mechanisms of genetic mutations. The installation consists of one retro-projected screen that represents the artificial life environment. In front of the screen the observers can interact with the environment itself. Two video cameras detect the positions of the observers, which become zones of life germination. The observer can see filaments growing from his location and interacting with the ones generated by other observers. The population evolves, developing emerging behaviors rendered as continuously new shapes and graphical/acoustical patterns.

The images represented on the screen are the rendering of the 2D life space where the individuals move and live. In addition to the filament position, the color is redefined at every cycle. Every graphical variable (hue, saturation, value, width of the line) is connected with some specific features

in a few words, the artificial societies work as generators of virtual metaphors for the real world. This concept could be considered one of the key themes of Planckon artworks: exploring the artificial being and artificial societies as a digital mirror in which the human beings' culture is reflected. Creativity, imagination, aesthetics, language can be extended/explored in artificial beings, built on the personal vision of the artist, and modified during the digital life evolution. In order to carry out this exploration there is a fundamental problem to solve: how we can communicate with artificial beings? Or better, how can humans and artificials develop a creative inter-contamination? In the following we report our most significant interactive installation exploring these directions.

of the individual recorded in the genetic map like: specie, character, irrationality, curvature, direction, position, age and level in the genealogical tree. The different combinations of the models allows an impressive variety of colors, tonalities and patterns. The global graphical results depend very much on the filament dynamics and society evolution. The collective development constitutes a new entity with its own autonomous and coherent pattern and with characteristics descending from the interaction and features of the population of individuals (Figure 1).



Figure 1: "Solo", a society generated by the evolution of a single lineage

Changing the parameters of the process, the set-up generates very different patterns, remembering the growth of populations (plants, animals, neural networks), landscapes (rivers, fractures, mountains, cultivated fields), human artifacts (chips, glass fragments, architectures) visions (anthropomorphic shapes, animals) or simply emotional attitudes.

The evolution process generates strong changes in the modality of the colonization of the life space. This mechanism is due to the dynamic action of dominant individuals who act like pioneers pushing the life in the void space. During this colonization they create strong divisions in the space and the subsequent colonization develops local communities of individuals (micro-societies). The action of the pioneers creates a mechanism of islanding which appears in the images as the coexistence of different graphical and acoustical phe-

notypes with a limited contamination. Another interesting aspect is the change in the individual phenotypes during the evolution, due to an emergent selection. At the beginning, smooth curves are self-selected due to the higher average life they are able to reach.

During the evolution the micro-societies characterized by straight lines are filtered because of they are not able to bypass obstacles (high coherence, low flexibility). Too-chaotic micro-societies (high level of irrationality in the curvature changes) are filtered because the individuals clash with each other (internal fighting and chaos). In the final part of the evolution, the available space is reduced and the most suitable phenotypes are the micro-societies with short paths, high reproduction rate and medium irrationality. These kinds of societies are able to diffuse in every available space.

Sound Dimensions in Alike Architecture

This mechanism produces interesting evolving sound and graphical patterns. As far as sound is concerned, in the large population implementation we built, every individual is the bearer of a sound that changes at each evolutionary step. The best individuals of any species are selected on the base of a fitness indicator depending on the energy they catch from the interacting people. These individuals access the available sound channels, determined by the currently-used sound system, and are able to play sound patterns. As in color modeling, the sound characteristics of each individual are built on the individual genetic and environmental features. A different instrumental timbre is assigned to each species. The sound timbre reflects very complex information related to the matter, i.e. to the physical characteristics of the sound-generating body. This important feature is mapped here to the whole set of genetic codes through an heuristic process under the control of the artist.

In addition, a sound dynamic is established between the movements of the individual in the space and the pitch of the sound. As explained in the previous section, the space is explored by the individuals following both the genetic code and the influence of the environment, and this movement is mapped on a sparse musical scale selected among standard musical modes and chords (Chromatic, Major, Minor, Melodic, Minor Harmonic, Pentatonic Major, Pentatonic Minor, Blues, Major, 7th, 7th dominant, Diminished, etc.). Changing the musical mode, the global

emotional impact is very different: changing from chromatic to major, for instance, the overall impression gets more relaxed. This modal information could be recorded in the genetic map or changed by the evolution of the genetic code if self-giving rise to a gene mutation of the overall acoustic landscape.

Other important sound features such as amplitude, roughness, rests, duration, etc., are also tied to the local dynamics of the evolution due to the path followed by the individual as a result of the environmental constraints. The sound amplitude is also used in combination with the interaction tracking mechanism described in the following. This mechanism translates the proximity of interacting people to the installation's screen into sound loudness. For example, if somebody approaches the screen, the sound gets louder. The global result is the development of many parallel melodies with similar characteristics but different scales, timbres and sometimes modes or tonalities. It is important to note that the different phenotypes developed during the evolution (i.e. the reproduction rate or the movement randomness) are clearly apparent in the acoustical dimension where the human ear has an incredible power of dynamics perception. The translation of the alike phenotypes into both image and sound dimensions produces a strong synergy of the two media, thus enhancing the perception of the system evolution.

Interaction. The Real People Give Life Chances to the Artificial Ones

Two video cameras are located at the bottom and on the left side of the screen. The signals of the cameras are sent to the computer and the 3D distance map of the observer body from the screen is computed in real time. The observer activity is normalized and transformed in the energy map that determines the life activity in terms of higher filament dynamics and higher reproduction rate. In this way the real people can interact with the artificial society influencing the path of evolution and pushing some specific species of individuals.

The interacting observer cannot operate as a deterministic control, but can only stimulate the artificial society, whose answer depends by the character of the individuals solicited most. Also the observer can push some specific colors or sounds, experiencing the emergence of some specific graphical and acoustical phenotypes. It is interesting to note that the interaction of the participating people widens the possibility of evolution. Generally the people, with their movements, try to push a specific phenotype at a time using the hands as a sort of life brush. During the interaction they alternate the balance of the development between several phenotypes, influencing the evolution and composing vibrating patterns and sound architectures.

Future Directions: Evolvability



Figure 2: Interaction between real people and artificial individuals

The concept of evolvability is connected to the potential of evolution of an artificial society. The scientific simulations are built in order to explain natural mechanisms of evolution or animal behavior or to solve practical problems. In these cases we have no need to build an extremely fast evolving system. At the contrary, when we want to use life for creativity and aesthetics, the needed degree of evolvability corresponds to the dimensionality and richness of our language. A first degree of freedom is the possibility to evolve the information transported by the individual itself (color, sound, images, shape, text, etc...) or the behavioral parameters written in the genetic map (dynamics, interaction, reproduction, life & death, etc...). This is important in order to generate different relations and different modalities of aesthetic self-organization. This is the level reached by Plancton at this moment with the installation *Relazioni Emergenti*. The next step we would like to reach is to give to individuals the ability to evolve the behavioral and phenotypic models and the genetic structure. This possibility enlarges incredibly the complexity of the future-generated creatures. This could be a good base to really open the evolution and give the individuals the possibility to develop some features like language and, in the long term, digital native cultures. This is exactly the direction of a new artwork of Plancton, at the present under construction.

References

[1] F. Annunziato, M. 1998. The Naguel Experiment, In Proc. of 1st Int. Conf. Generative Art, Milan (IT).

[2] Annunziato, M. 1999. Emerging Structures in Artificial Societies, In Creative Application Lab CDROM, Saggreph, Los Angeles (CA). For Artificial Societies see also www.plancton.com

[3] Annunziato M. and P. Pierucci, 1999. The Art of Emergence, In Proc. of 2nd Int. Conf. Generative Art, Milan.

[4] M. Annunziato, P. Pierucci, Emergent Relationships, In Int. Conf. AIIA VII Portland (OR), 2000. Workshop "Artificial life in Art, Design and Entertainment".

Mayno Annunziato and Piero Pierucci

Plancton Art Studio is an interdisciplinary group focussed on interactive installations designed for digital and virtual territories. The creative potentiality of the artificial societies their artworks have been exposed in international art and science festivals, international workshops, Imagina, Aile Virtual, etc. Annunziato is director of a laboratory ENCA Art that's virtual networks, artificial life and Piero Pierucci is director a laboratory working on virtual entities and 3D sound modelling. Both are authors of more than one hundred scientific publications. Annunziato has been mentioned by NASA JPL <http://tiny.planetology.nasa.gov> in 2000 as one of the top 50 most scientific websites for the Mars Millennium project. plancton@plancton.com <http://www.plancton.com>

TechnoSphere: A life and the Sublime

Jane Prophet

"Mathematics possesses not only truth, but supreme beauty – a beauty cold and austere like that of sculpture." Bertrand Russell

TechnoSphere, was launched in 1995 as an Arts Council of England funded website created by Jane Prophet (artist) and Gordon Selley (graphic designer and computer programmer). In 1998

Online Participation

The digital ecology of the 3D world, which is housed on our server depends on the participation of an on-line public who accesses the world via the Internet. Users create their own artificial life forms, building carnivores or herbivores from component parts (heads, bodies, eyes, and wheels). Their digital DNA, or genetic specification, is linked to each component part determining speed, visual perception, rate of digestion and so forth. Once a creature is built, users name their digital creature and it is tagged with their email address and put into the 3D world.

As the creatures grow, give birth, move, evolve and die they send brief email messages, post cards 'home' to the users that designed them, describing the key events in their artificial lives. Users can visit the website and see 2D snapshots of their beast at any time, check family trees,

Mark Hurry, Director of Digital Workshop Ltd joined the team to develop the real-time 3D version. The TechnoSphere concept is unique in its combination of artificial life, the internet, and in its latest version, real-time 3D graphics. It has already attracted over 650,000 users who have created over a million creatures.

world statistics and trace other creatures and the users that designed them. For example users might be interested to find out more about a creature which their beast had interacted with, they can use the ID number of the other creature which is sent in the email messages to track that creature down.

TechnoSphere differs from many a life systems as rather than focussing on one creature or a small group, it supports many tens of thousands of competing life forms, typically 20,000 creatures are alive at any one time. The proprietary technologies that support the website are scalable, and can be developed to support a much larger community of up to 1 million creatures.

TechnoSphere is an a life community contaminated by human intervention. Web surfers visit www.technosphere.org.uk and create artificial life forms using a simple 2D interface. These creatures are deposited into a digital ecology teeming with thousands of life forms. Carnivores and herbivores search for food, kill for food and in defence, mate and bear children. They send email messages to the user that created them, take their place in the TechnoSphere family tree and compete for resources. TechnoSphere began as an artificial life simulation (and as 'newbies' to a life we were hesitant about claiming it was more than a simulation). It has developed a compelling social dimension that goes beyond the heart of its code: the a life engine NovaGene, written by Gordon Selley which sets the parameters for the behaviour of the artificial creatures, and has spread to the humans that interact with them.



Figure 1 TechnoSphere creatures from the real-time 3D version

Interference

The creative process goes beyond the interference of Gordon Selley. Mark Hurry or myself all visitors that make creatures are part of the creative process. The constant injection of new creatures made by users, rather than bred by existing creatures, interrupts the ecosystem. Some users make just one creature and others return time and time again making new beasts as they 'interpret' their creature's life compare it to the "Top Creatures" list featured on the site, and try to make a faster hungrier or more fecund artificial life form. John Sykes Fletcher, a TechnoSphere user, writes on his homepage:

Social Networks and Networked Societies

The TechnoSphere homepages are just one aspect of the social network of the project; they enable browsers to check up on creatures by typing in an animal's ID number to see what it is doing at any given time. The homepages act as an interface between the human world and the alive system that is TechnoSphere. The updated map function tracks creatures with an 'X' marks the spot in real time and as users reload the map page they see carnivores approaching their creature or their creature merging with another during predation or mating. This is graphically simplistic but users tend to 'fill in the gaps' of the narrative and make the data compelling, as seen by the quote below from a user watching the map function page:

" My new creature, a carnivore, is Amazing Salamander Twist. Its number is 77366 and you can monitor Twist at the address below. The picture makes it look as though its eye is stuck on its teeth. Now there's an evolutionary advantage. Uh oh, there are about 20 carnivores and 0 herbivores on my screen. Gulp. He's dead too. "Eaten by prey" My pride!"
[http://web.pitas.com/tlm/14_12_1999.html]

"Both the greediest (24612) and the best predator (24612) (carnivores) have these mouth parts and no other similar attributes. It was the reason for the Yum_Yum species creation. The fastest creatures (9003) in TechnoSphere appear to have these types of wheels. As the Unicentrix are carnivores it's hoped this will help them succeed. Both Yum_Yum's and Unicentrix's appear quite successful - Unicentrix are a crossbreed. An Archascrew's early death prompted a more precise copy of the fastest creatures in TechnoSphere" [www.know.demon.co.uk/me/techno.htm]

The functionality of these pages are part of the collaboration between Gordon, Mark and I and the users of the site who email us with suggestions for new features or developments for existing ones. Users can be very pro-active; one UK user has developed a bespoke java scripted front end to the TechnoSphere Creator [<http://www.uncommon.demon.co.uk/technosphere/>]

In addition to the official TechnoSphere pages users have made hundreds of webpages that act as family albums and memorials to their creatures. Virtual graveyards, often complete with images of tombstones and wreaths of flowers, list the dead some with poetic texts that imagine the details of creatures' lives.

Scale and Nature: From Sublime to Minute to



Figure 2: A still from *Decay* showing an avenue of fractal trees in a Norfolk parkland

Virtual

Debate surrounding artificial life and virtual societies ranges from utopian to dystopian, and there are many people who have felt that projects such as TechnoSphere are dangerous, frightening, and 'out of control'; while others find a beauty in alife that 'transports' them. In the study of aesthetics, the human body is traditionally used as a field of reference from which we derive notions of scale in the sublime. The sublime experience is one that combines a sense of beauty with a sense of fear. The mixture of fear and beauty initiates transcendental feelings. In the late 17th century there emerged a new feeling for nature and natural beauty. Alongside art, nature became a subject worthy of aesthetic contemplation. With its vast scale, sweeping landscapes and impenetrable mountain ranges, nature partook of, indeed largely sustained the aesthetic of the sublime, these views were usually marked by a lack of boundary or frame (i.e. not seen from a window). An overpowering sense of overwhelming scale felt by those contemplating nature (a mixture of fear in being overpowered, and of appreciation of beauty) was thought to prompt consideration of the Infinite God who had, as the ultimate artist, created the landscape. At these moments religious experience shared blurred boundaries with the aesthetic sublime.

In contemporary Western societies, ideas of nature as sublime have been eroded as we have conquered even the highest peaks and lost most of our opportunities to view vast landscapes as building programmes and pollution have rendered the horizon invisible. At the same time we have developed artificial life systems and installed them in computer space, a locus without horizon. In 1759, the

philosopher Edmund Burke includes attributes such as a size small enough to comprehend in his definition of the Beautiful, in contrast to his Sublime, which is that which is too great for the mind to grasp in a rational manner. But what happens when objects and images are too small to comprehend, when they become so minute that their scale is terrifying? Do they then slip from the Beautiful into the Sublime?

In recent years, across disciplines ranging from physics to biology to mathematics, there has been a re-emphasis on scale, but this time the focus is on the very small. With electron microscopy etc. we again use our bodies as a field of reference for scale, but this time to contemplate the very small. The sublime of the small contains the mixture of beauty and fear - medical images from hitherto invisible realms of the inner landscape of the body are often beautiful; and at the same time they frequently signify illness or disease. These images of diseased cells and contagion prompt fearful feelings of an unfathomable wilderness, an inner landscape out of our control and untameable. Alife systems take this sense of scale and sublime terror and beauty a step further. Here the 'organism' is not just small, but invisible - virtual. The 'body' of the artificial creature and the 'landscape' it inhabits have become pure data. It is as if we have almost come full circle, once again nature is untameable and out of control. It may seem inappropriate to define alife as 'natural', but the boundaries between the natural and artificial have been blurred for a long time and to find the divide is increasingly problematic.

Vitality: The Dynamism of Order and Disorder

The mathematician Eilenberger has discussed at length the relationship between randomness and order in images that are found to be 'beautiful'. But this is not a new idea; it can be traced back to Plato who defined beauty as a mixture of these two elements. In 1969, the Institute of Contemporary Art in London, UK, held *Cybernetic Serendipity*, an exhibition of works made with, or by, computers. Included was a piece by Michael A Noll which illustrates well the randomness + order = beauty equation, and more besides. Noll, like many of the exhibitors, was a programmer who worked for Bell laboratories.

Noll made a series of programmes to simulate the works of artists such as the painter Mondrian. In this piece he exhibited one of these computer generated images next to a print of a Mondrian and asked gallery visitors to make an informed

guess as to which was which. 70% of visitors thought that the computer generated image was the Mondrian, and stated that this was due to it appearing 'more random'.

TechnoSphere's landscapes are produced in a similar fashion, with fractal code producing 'natural' looking terrain and a virtual 'Johnny Appleseed' randomly sowing trees among the foothills and plains. This work has been taken much further by Gordon Selkey and myself in a series of prints called *The Landscape Room*, and in the moving image project, *Decoy*, both of which feature complex fractal trees growing in photographic landscapes of English stately homes.

The trees, the landscapes and the Nova Gene al-

ife engine are all based on chaotic systems: they are deterministic, by which I mean that there is a determining equation ruling their behaviour or appearance. Like all chaotic systems they are very sensitive to the initial conditions. A very slight change in the starting point can lead to very different outcomes. This makes a chaotic system fairly unpredictable.

Some of the events in TechnoSphere illustrate this, and users add an extra chaotic and unpredictable dimension. When we first launched TechnoSphere we 'stocked' the terrain with a few thousand creatures made randomly by the system. They were all the same age, babies. As they reached sexual maturity (all at the same time) there was a veritable orgy in TechnoSphere and a tremendous population explosion. This resulted in unexpected emergent behaviour: herbivores moved en masse across the plains and carnivores attacked them from the edges. The herbivores were eating our virtual grass. And as they depleted each square of food in the terrain it became empty and they had to move on, hence the mass movements. Then they ate themselves into a fractal coral and the carnivores formed a line at the mouth. This was the start of

what became known as 'Vending Machine Valley'. Carnage ensued as the herbivores tried to leave that area, once the food had run out, and the carnivores picked them off. When users made a glut of carnivores a few years ago, herbivores were almost wiped out and the population became unstable. As users realised what was happening they began to make dozens of herbivores and this in turn interrupted the population's recovery.

Our next major development of TechnoSphere will be to open up the system to user intervention even further, to increase the dialectic interference between users and the aife system, to accelerate cross-contamination between human users and the virtual world. I write this from England, a green and pleasant land of empty fields and stacks of burning lambs. As foot and mouth rips through the farming community and farmers communicate from the quarantine of their small holdings via phone and web, this seems just the right time to be thinking about artificial life, communication systems, nature, and contamination.



Jane Prophet graduated in Fine Art from Sheffield Hallam University, 1987, completing her PhD at Warwick University in 1995. Her work includes large scale installations, digital print, websites, and CD-ROMS. She is currently a research fellow at the University of Westminster and a lecturer in Fine Art at the Slade School of Art.
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n., pronounced eye-lum.

1. A Greek word for the exploding mass from which the universe emerged.

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